# 細粒磁鉄鉱緩和の新しい温度ー時間関係と津波巨礫年代推定への制約

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# A new time-temperature relations of magnetite nanoparticles and its constraint to Tsunami boulders viscous dating

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Tsunamigenic coral boulders at Ishigaki Island have been well dated by radiocarbon age, indicating the timing of paleo-tsunami events. Although these ages are consistent with the initial tsunami event by the emplacement of coral boulders at the low latitude ocean, the subsequent tsunami events and also events at high altitude regions can be undetermined. Paleomagnetic viscous dating overcomes the problem because the boulder can acquire viscous remanent magnetization parallel to the Earth's magnetic field with ages. Neel's thermal relaxation theory on single domain magnetite particles predicts the time-temperature relation for the viscous relaxation. Following Pullaiah et al. (1975), we can derive a time-temperature nomogram for single domain nanoparticle ensembles describing that a remanence acquired during a time at a room temperature in nature can unblock during shorter heating step at higher temperature in a laboratory. However, there is some exception that paleomagnetic viscous dating is not consistent with radiocarbon age. To pursue the exception, we revisit a Neel's thermal activation theory of magnetic relaxation, which is a fundamental basis of rock and paleomagnetism. The exceptional nomogram does not fit natural rock examples, which show anomalously higher unblocking temperatures than predicted by Pullaiah's nomogram. Better agreement has been found for the nomogram based on Walton (1980)'s calculation invoking viscous acquisition. However, Walton's formula fails to deduce a previous Dunlop's experimental viscous relaxation data (Dunlop 1983). The Dunlop's data showed a concave down slope of logarithmic viscous relaxations with increasing ambient temperature. To fit this data, I extend the Neel's exponential relaxation model to a new time-dependent William-Watts relaxation one. This extension generates a stretched exponential viscous relaxation and agrees well with the Dunlop's data. Using this stretched exponential viscous relaxation, I derived a non-linear time-temperature relation of magnetite nanoparticles, involving the Neel's exponential model and the exceptional natural data. To date unknown natural rocks by our new viscous dating, however, the magnetic granulometry carrying the remanence is a key ingredient.